INTERACTION BETWEEN LAND AND LABOR MARKETS

By

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This dissertation is dedicated to my family

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The dissertation studies the role of amenities in the land and labor markets. A model allowing for interaction between the two markets is presented and estimated. In contrast to previous studies these two markets interact only when the amenity is scarce. An amenity is defined to be scarce when urban residents bid against each other for land tracts possessing the amenity. It is no longer economically efficient for farmers to use such land. It is shown that while all amenities influence wages, only scarce amenities affect land prices. The model is estimated using aggregate data for 119 U.S. metropolitan areas. The model's predictions are supported. Coastal locations appear to be scarce, especially those with a temperate climate. Land with both these attributes is found almost exclusively in California. It is also shown

that education plays an important role in determining worker demand for amenities.

CHAPTER I
INTRODUCTION

Wages and rents vary across regions. Considerable attention has been given to these differentials and their causes. Though some of the differences in wage rates can be explained by adjusting for the cost of living, wage differentials persist even after the cost of living is accounted for (Coelho and Ghali 1971 and 1973; Ladenson 1973; Johnson 1983; Sahling and Smith 1983; Tremblay 1986; Jackson 1986).

The theory of compensating wage differentials suggests that these differentials result from variations in the amenity bundles available to consumers at different locations. Assuming that workers are mobile across regions, a worker will choose to live and work where his utility is maximized. His utility is a function not only of his nominal wage but also of the price level and the amenity bundle available to him. Hence, low amenity locations must offer higher wages to attract workers. Some studies have attempted to measure the implicit prices of urban amenities using hedonic price methods.

Nordhaus and Tobin (1972) estimate the cost of urbanization to be eight percent of average family

disposable income in 1965. Hoch and Drake (1974), and Kenny and Denslow (1980), find climate to be an important influence on wages. Both studies find that wages first fall and then increase as average July temperatures rise. Rosen (1979), Izraeli (1977), Getz and Huang (1978) and Blomquist et al. (1988), all find wages to be responsive to environmental and sociological factors. Pollution and crime are commonly studied (dis) amenities.

There have also been a few attempts to estimate the influence of amenities on rental values. Ridker and Henning (1967) used cross sectional data from the St. Louis metropolitan area in 1960 to estimate the effect of variations in air pollution on property values. They found that property values increased substantially with drops in sulfation levels. Polinsky and Rubinfeld (1977) also used data from the St. Louis area. Their conclusions concur with the findings of Ridker and Henning. Blomquist et al (1988) find rental values decline sharply with increased pollution.

The evidence so far suggests that amenities affect the geographical distribution of population and industry, and cause variation in wages and in land prices across areas. As Polinsky and Rubinfeld (1977) point out, changes in environmental conditions have important effects on the structure of SMSAs (standard metropolitan statistical areas). These changes affect firms as well as workers. To

estimate the net effect of an environmental change, both land and labor markets must be analyzed jointly. For example, if residential land becomes very expensive because of improved amenities (such as a beach), then wages must rise to compensate workers for the increased cost of living. At the same time the better amenities make workers willing to accept a wage cut. By and large, economists have ignored this interaction between the land and labor markets. Roback in her 1982 paper considers the interaction but fails to explore its consequences fully. She ignores the presence of transportation costs. This results in her model having monotonic amenity effects when the amenity is production neutral, i.e., rents increase and wages decrease as amenity levels increase.

In the following chapters I present a model which explores the interaction between the land and labor markets and the role of amenities in the determination of wages and rents. The model hinges on the distinction between scarce and non-scarce amenities. Before going on, let me explain what a scarce (non-scarce) amenity is. An amenity is scarce if its supply is limited enough that individuals outbid agriculture for all land tracts with that amenity. For example, a temperate climate is an amenity but not a scarce one in general. However, combined with a seaside location a temperate climate is scarce. For example, large areas of the southern United States are used for

agriculture, but no farms are found along the coast of California or Florida. Economic theory suggests that the presence of scarce amenities will determine the premium consumers (workers) are willing to pay for a given tract of land. This in turn will affect the wages they receive. If land prices do not vary much with amenity levels (i.e., amenities are not scarce), then increases in amenity levels tend to reduce wages. However, if land prices are increasing, then wages may increase because of a cost of living effect. This is discussed in greater detail in Chapters II and III of the paper.

In the next chapter I describe the model used. In Chapter III, I discuss the empirical implications of the model and some directions for testing the model. Chapter IV, describes the sample used. Chapters V and VI present the empirical results. By and large, the results are consistent with the theory. A higher level of amenities reduces wages while land prices rise only when the amenity is scarce.

CHAPTER II
THE MODEL

My model studies the interaction between the land and labor markets. Roback (1982) has been the only other researcher to model interaction between the two markets. In her model there is no intercity trade. This results in continuous interaction between local land and labor markets. My model allows for intercity trade. As a result the land and labor markets interact at discrete intervals. The range of interaction is determined by the nature of amenities available at a given site. The presence of scarce amenities leads to interaction between the two markets. Non-scarce amenities do not influence the land market. Hence, there is no interaction between the land and labor markets.

The two models have substantially different predictions about the behavior of wages and rents. Roback's model predicts that as long as amenities are production neutral wages will fall with increases in amenity levels while rents will increase. When the amenity is unproductive wages fall as the amenity increases, while rents may increase or decrease. Finally, she predicts that

when the amenity is productive rents will increase as amenity levels increase, while wages may go either way.

In my model increases in amenity levels tend to lower wages. Land prices are affected by scarce amenities only. They increase as scarce amenities increase. This induces cost of living increases in wages. Hence, the net effect on wages is indeterminate when amenities are scarce. My model also predicts that firms will be willing to locate at sites further away from the market if they have more amenities. This prediction changes when amenities are scarce or unproductive.

Let me now turn to my model. It describes an economy with many cities each endowed with a given, fixed quantity of an amenity S, where S varies continuously over the interval (S_1, S_2). All individuals produce and consume a single composite commodity X. Its price, which is assumed to be exogenously given, serves as the numeraire. Capital and labor move freely among cities, while land stays fixed for any given city but shifts freely among uses. Intra-city commuting costs are assumed to be zero while inter-city commuting costs are assumed to be prohibitive. This precludes the possibility of a worker living in one SMSA while working in another. All workers are assumed to have identical tastes and skills. Each supplies one unit of labor independent of the wage rate w, and consumes l^c units of land. The rental price of land is r dollars per

unit. Thus, the consumer's problem may be stated as follows:

(2.1) Max $U(x,l^c;s)$ s.t. $w = x + rl^c$, with $dU/ds > 0$.

The market equilibrium condition is given by the indirect utility function V associated with (2.1). It tells us that given their preferences (which are assumed to be identical in my model) all individuals, regardless of variations in location, wage rate, the rental price of land or the amenity level, attain the same utility level. This is expressed in (2.2).

(2.2) $V(w,r;s) = k$, $V_s > 0$.

If this did not hold, i.e., the utility levels of workers varied with location, then workers would move to locations where utility attained was greater. This would result in imbalances in the factor and goods markets at these locations. There would be an excess supply of labor and an excess demand for land at the given prices. To clear the markets wages must fall and rents increase. This will continue until utility levels are the same at all locations. The ith firm at any given location produces the good X according to a constant returns to scale (CRS) production function.

(2.3) $X_i = f(l^p{}_i, N_i; s)$, with $\Sigma l^p{}_i = l^p$ and $\Sigma N_i = N$.

Here l^p is the total land used in production and N is the total labor force of the city. Assume that all output must be shipped to a given market, whose location is fixed. In doing so, the firm incurs a cost of t dollars per unit output per mile. Transportation cost equals tz, where z represents miles from the market.

Since price is exogenously determined, each firm minimizes cost given its production function. As f is CRS, the unit cost function (which is identical for all firms) is used for all analysis. In equilibrium unit cost equals product price. In this case product price equals one i.e.,

(2.4) $C(w,r;s) + tz = 1$.

If this equality did not hold, firms would have an incentive to move their capital to more profitable cities. As usual, we have $C_w = N/X$ and $C_r = l^p/X$. We also have C_s >=< 0 according as the amenity is unproductive, neutral or productive.

The introduction of trade and transportation costs leaves the market indeterminate. To complete the model I introduce the land market equation.

(2.5) $r = A + h(s)$, $h'(s) \geq 0$.

Here A represents the effect of the agricultural productivity of land while h(s) represents the amenity effect. There are basically two groups of consumers bidding for land, farmers and consumers. The value of the land to the farmer depends on its productivity in agriculture. As long as the rental price per unit of land is less than or equal to the marginal product of the land, the farmer will be a consumer of land at the given location. Hence, agricultural productivity helps to determine a base price for land. All users of land at the given site must pay rent equal to at least the value of the land in agriculture.

As more and more consumers locate in an area with a particular amenity value S_o, more and more land is taken out of agriculture and used for residences. At some point farmers are priced out of the market and all land with amenity level S_o is used for residences. The amenity is said to be scarce at this level S_o, since consumers must bid against each other for the available land[1]. Scarce amenities have strong positive effects on land price, i.e., $h'(s) > 0$.

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1. An amenity is defined to be scarce in some range of values if consumers are the marginal bidders for land with these amenity values. The definition of scarcity used here differs from the generally accepted view that most goods are scarce.

An example of a scarce amenity is a beach. In the U.S. farmers are priced out of the market for land tracts along a beach. Consumers bid against each other for these tracts. Non-scarce amenities have little or no positive effect on land prices, i.e., $h'(s) = 0$. Occasionally agricultural productivity may be influenced by some amenities and this may induce a weak positive amenity effect even when the amenity is not scarce. For example, if a given tract of land has an inadequate supply of water but is otherwise fertile, the construction of a new canal system will increase the marginal product of the land and, hence, land prices overall, even though the amenity in this case is not scarce.

Differentiating equations (2.2) and (2.4) and solving simultaneously, I obtain the wage and location gradients.

$$(2.6)\quad dw/ds = -(V_r r_s + V_s)t/V_w t.$$

$$(2.7)\quad dz/ds = (-V_w(C_r r_s + C_s) + C_w(V_r r_s + V_s))/V_w t$$
$$= -(C_r r_s + C_s)/t - (C_w/t).(dw/ds).$$

In general I expect most amenities to be neutral in the production process, i.e., $C_s = 0$. The direction of the gradient is then determined by the sign of r_s. If the

amenity is not scarce, $r_s = 0$ and the gradients are as follows:

(2.8) $dw/ds = -V_s/V_w < 0.$

(2.9) $dz/ds = -(C_w/t).(dw/ds) > 0.$

Any increase in amenity levels with no change in wages increases consumer utility. Equation (2.2) no longer holds. This attracts workers from other cities and increases the demand for land and the supply of labor at the given location. Since $r_s = 0$, land rents are unchanged. However, to make workers indifferent between locations, wages must fall until equation (2.2) is satisfied once more. Hence, high amenity locations will have lower labor costs. This encourages firms to locate there. Firms are willing to locate at more distant sites and incur higher transportation costs because wages are lower in these nicer areas.

The adjustment process continues until the increase in transport costs is sufficient to offset the lower wage rate and make firms indifferent between locations once more. Thus, if an amenity is not scarce and it is production neutral, firms can locate further away from the market as amenity levels increase. As more firms and

consumers move to high amenity locations, SMSAs are likely to develop at these locations.

Now consider the case when the amenity is scarce, i.e., $r_s > 0$.

(2.10) $$dw/ds = -(V_r r_s + V_s)/V_w \gtrless 0.$$

As amenity levels increase, rents increase and this exerts an upward pressure on wages to compensate for the higher living costs. This secondary effect will at least partially offset the pure amenity effect of lower wages and may even reverse it.

(2.11) $$dz/ds = -C_r r_s/t-(C_w/t).(dw/ds) \gtrless 0.$$

Comparing equation (2.11) with equation (2.9) we see that the firm now experiences a direct rent cost effect. This reduces z. In addition to this, the wage effect may also be negative if wages increase as amenity levels increase. This will also reduce z. As a result, some firms will be discouraged from locating in areas with high levels of scarce amenities, especially if they are far from the market.

Summing up, locations with higher amenity levels tend to have lower wages. If the amenity or amenities present are scarce, rents will rise. This leads to cost of living

increases in wages so that worker utility is unchanged across locations and equation (2.2) holds. In some cases the rent effect will be larger than the initial decline in wages and the net result will be higher wages than in areas without the scarce amenity.

The response of wages and land rents to the changes in amenities depends on the definition of scarce and non-scarce amenities. The model and its predictions differ from previous work largely because of the assumption that amenities are dichotomous in nature. This aspect of the model and its empirical consequences will be discussed in later chapters.

The model remains fundamentally unchanged when amenities are allowed to influence the production process. A discussion of the two alternative ways in which amenities can influence the production process and the behavior of land and labor markets is given in Appendix A. The model can also be extended to incorporate the non-traded goods sector. The addition of the non-traded goods sector introduces a multiplier effect and magnifies the size of the gradients. This aspect is also discussed by Tolley (1974). A discussion of the four sector model and the multiplier is given in Appendix B.

CHAPTER III
EMPIRICAL IMPLICATIONS OF THE MODEL AND TESTING PROCEDURES

This chapter looks at the empirical implications of the model presented in Chapter II. The results obtained are formalized and a testing procedure is suggested. Chapter IV discusses the sample and the theoretical predictions with respect to the variables included.

The analysis of the previous chapter suggests that the land and labor markets interact only for some subset of amenity values. The points of interaction are determined by the level at which amenities become scarce. An illustration of the result is given by Figure 1.

As long as amenity levels are below A^*, changes in them have little (broken line) or no (solid line) effect on land prices. Up to the point A^*, the amenity is not scarce. Beyond A^*, i.e., once amenity levels are sufficiently high, the amenity becomes scarce and land prices increase sharply with increases in amenity levels. This also affects the behavior of wages.

As amenity levels increase, with little or no corresponding rent change, wages fall. As the amenity becomes scarce, further increases in amenity levels

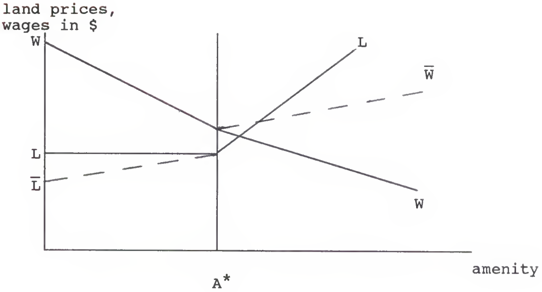

Figure 1.

increase rents. This induces a compensating wage increase. The net fall in wages is smaller. In some cases wages also increase (shown by broken line rising upward in figure 1). These results can be summarized as follows:

(3.1) $P_{land} = \alpha + X\beta + bA_1 + cA_2$.

(3.2) $wage = \bar{a} + X\bar{\beta} + \bar{X}\tau + \bar{b}A_1 + \bar{c}A_2$.

$$
\begin{aligned}
A_1 &= A \text{ for } A \leq A^* \\
&= A^* \text{ otherwise.} \\
A_2 &= A - A^* \text{ for } A > A^* \\
&= 0 \text{ otherwise.}
\end{aligned}
$$

Here A is the observed value of the amenity. The vector X consists of variables influencing the supply and demand of land and, hence, land prices and wages, which include a measure of the long term unemployment rate (see Appendix C for definition), the ln (natural logarithm) of the price of agricultural land, the ln of SMSA population, and a measure of restrictions on land available for SMSA expansion. The vector $\bar{X}$ consists of human capital variables. Variables included are age, experience, the percentage of white males and the percentage married in the sample, and the percentage of foreign born in the SMSA. Definitions of the variables included and their sources are

given in Appendix C. For ease of exposition I shall assume a one-amenity economy for now. The results obtained are easily extended to the multi-amenity case.

The objective is to estimate the model and test the following hypothesis.

1) $b \geq 0$, $c > b$, and

2) $\bar{b} < 0$, $\bar{b} < \bar{c}$.

If the hypothesis is not rejected, then the model presented in Chapter II is valid. Discrete interaction between the two markets will have been established. It will follow that only scarce amenities play a role in the determination of land prices. This is an important result that has been overlooked in the existing literature. Model estimation is complicated by the fact that A^* is unobserved.

Sixteen observations on average wages were collected for each SMSA. Each corresponded to a different age and educational category. Data were collected for prime age males only. This avoids the problems associated with nonparticipation in the labor force. Only one observation was collected for land price for a given SMSA. Due to the interaction between the land and labor markets, the wage and the land price regressions are not independent. The model must be estimated jointly. However, the structure of

sample presents a problem. It is very difficult to run a SUR (Seemingly Unrelated Regression) when the number of observations for the two dependent variables is different.

I came up with two possible solutions to the problem. The first uses a separate wage regression for each of the sixteen age and educational categories. Thus, the system consists of seventeen regressions (including the land price regression). Sixteen separate estimates are obtained for the coefficients of each of the variables included in the wage regressions. Interpreting the overall effect is not easy. To avoid confusion, all the coefficients of the wage regressions are not presented. Instead the mean, the variance, the maximum value and the minimum value of each coefficient are given. I also ran F tests and the Pearson's P_g test to get an indication of the overall significance of the variable on wages. The coefficients for the land price regression are presented as obtained.

As an alternative I used dummy variables to capture SMSA differences in wages not due to variations in human capital. I regressed wages on dummy variables for each SMSA, education categories and age group. The estimated coefficients of the SMSA dummies were then used as values for the dependent variable to estimate amenity effects on wages.

Both methods involved a search for A^*. An iterative search was conducted to locate A^*. I started by

calculating the mean and standard error for each amenity and plotting amenity values against land prices. Using the information obtained, I chose an initial value for A^*, for each amenity. Proceeding one amenity at a time, a search was made over the neighborhoods of the initial spline values, the objective being to maximize R^2 for the system. The values obtained from the individual searches were used as starting points for the next stage in the search. All appropriate amenities were included in the regressions and a joint search was conducted to obtain spline values that maximized R^2. I tested the values obtained by running the regressions with spline values other than those estimated. I found that even a small deviation produced a substantial decline in R^2. The results obtained are presented in Chapter V. The search was conducted independently for both sets of regressions. It is, therefore, a sign of the robustness of the estimates of A^* that the same values were obtained for each A^* by the two independent searches.

SURE was used for the second stage of the SMSA dummies regression.

CHAPTER IV
THE DATA

The sample consists of one hundred and five SMSAs. All had a total population of at least a quarter of a million. The decision to use a SMSA as the unit of measurement was based on theoretical and practical considerations. Comparing a rural community with an urban center does not help in obtaining meaningful conclusions about the effect of amenities on land and labor prices. Differences in the basic structure of the two areas will be too widespread to permit useful comparisons. Most importantly, data are more readily available for SMSAs. Often they are the smallest unit for which data are published. The use of Census data for wages further restricted the data set to SMSAs with populations of a quarter million or more.

Census data were chosen over micro data from the Current Population Survey because of their increased coverage and greater generality. Grouped data reduces measurement error. It reduces the extent of bias in the data caused by over representation (under representation) of some groups.

The sample was limited to men between the ages of 35-54 years. This avoids selection problems associated with schooling and retirement. Almost all males in this age group are in the labor force. The sample was split into two groups. The first group consists of males aged 35-44 years, and the second group consists of males aged 45-54 years. This was done to take account of income variations arising from differences in experience. To deal with the problem of part time workers, I further restricted the sample to include only those workers who had worked for at least thirty-five hours per week and forty weeks in the census year. Dummy variables were used to group the men by educational attainment. The eight categories used cover education from primary school to post graduate levels. They are detailed in Appendix C.

Residential site price data were obtained from the Department of Housing and Urban Development's FHA Homes 1981. This is the only available source of comprehensive data on the average price per square foot of residential land. Low income families are over represented in it, since it collects data on families qualifying for FHA loans. There is no information on intra-city site location for such a large number of SMSAs.

This was the starting point for the sample. Data on site prices were available for one hundred and nineteen SMSAs. Some of these were dropped from the sample because

they failed to meet the minimum population requirement and no wage data were available for them. Other SMSAs were dropped because of incomplete data on city characteristics such as pollution, crime and weather. Data sources and units of measurements are described in Appendix C.

Data were also collected on human capital, amenities and factors influencing the local land market.

One of the human capital variables included is the percentage of SMSA population that is foreign born. I tried to obtain data on the percentage of foreign born men in the sample but these were not available. This variable is used as a measure of English language proficiency. Individuals with a poor command of the modal language have fewer job opportunities open to them and will receive lower wages than comparably qualified workers who are fluent in the language (Mc Manus et al. 1983).

To control for income variations arising from racial differences, I included a variable on the percentage of white males in each of the two age categories. Smith (1984) finds that there are no disparities in the treatment of blacks relative to whites once they are on the job. However, starting salaries for blacks are substantially lower. Smith suggests that this is the result of the relatively poor quality of schooling received by blacks. He finds that in 1910 Mississippi schools spent between 2 to 30 times as much on white as on black students. In 1920

black teachers across the country received substantially lower wages, and the student-teacher ratio was higher for black children. Given these statistics, I expect white males in my study to earn higher wages than their black peers.

I also included a variable on the percentage of men currently married in each of the two age groups. Existing studies have found that marriage increases the earning capacity of men, as it enables them to concentrate on the accumulation of human capital needed on the job.

One of the variables influencing the local land market is SMSA population. As population increases, demand for centrally located land increases. This causes the land rent gradient to shift up. Hence, the cost of living increases, and more land is allocated to residential housing as the SMSA spreads out. This is accompanied by higher wages.

Another variable that influences local land prices is the availability of additional land (currently used for agricultural purposes) at the SMSA's perimeter for urban use. If there are restrictions on land available (natural or manmade), increased demand for the remaining land will result in higher prices for land. I use a variable that measures on a scale of zero to one the fraction of the city perimeter that cannot be extended beyond current limits due to the existence of natural or manmade restrictions. For

example, Miami can acquire land to its south and north but not to its east or west. The eastern side borders on the Atlantic Ocean, while the western side borders on the Everglades.

The ln of the value of land and buildings per acre in agriculture was used as an approximation of the agricultural productivity of land. As mentioned in Chapter II, the agricultural productivity of the land helps to establish a base price for residential land. Higher agricultural productivity increases local land prices overall.

The long term unemployment rate is a good indicator of local labor demand and, hence, demand for residential land. It also provides a measure of the risk premium associated with unemployment. Areas with high rates of unemployment over time have depressed land and labor markets. Land prices are lower than in comparable locations. To attract workers to the area firms must compensate them with higher wages. I use an average of the unemployment rates reported in the 1960, 1970 and 1980 censuses as a measure of long term unemployment.

The amenity variables include two measures of crime. One measures the incidence of violent crime while the other measures the incidence of property crime. Both are expressed in terms of the rate per hundred thousand persons. The data were collected from the FBI's Uniform

Crime Reports for the United States. I expect workers to demand higher wages as compensation for living in areas with high crime rates of either type.

To measure the quality of the environment I used EPA data on the particulate level in the atmosphere. The compensating wage theory predicts that individuals living in areas with high pollution levels will receive higher wages than those individuals living in cleaner environments.

The effect of higher crime rates and pollution levels on land prices is not so clear. On the one hand, higher crime rates and pollution levels should both reduce the demand for land and, hence, result in lower land prices. However, consumers can usually avoid the increased pollution and crime in the SMSA by moving to a rural area on the outskirts of the SMSA. This reduces the demand for SMSA land and land prices are lower. At the same time the compensating differentials increase workers' wages. This may increase demand for land as workers substitute away from time intensive activities (e.g. outdoor sports) towards wealth intensive activities (e.g. housing). As demand for land increases land prices rise. The net effect on land prices will depend on the relative strengths of the various forces at work.

To measure the effect of temperature variations I used a combination of average July and January

temperatures. Looking at the data it appeared that a combination of warm winters and cool summers was scarce.[1] To capture this six categories were defined instead of the usual four. Three used July temperature as a base and three used January temperature as a base. The categories are as follows:

JULYC: It is characterized by cold winters and cool summers. It is equal to the average July temperature if it is less than 77°F and the corresponding January temperature is less than 42°F, 0 when the corresponding January temperature is greater than 42°F and 77 when the July temperature is greater than 77°F.

JULYP: This has the preferred mix of summer and winter temperatures. It is equal to the average July temperature when it is less than 77°F and the corresponding January temperature is greater than 42°F, 0 otherwise.

JULYH: This has warm winters and very hot summers. It is equal to the average July temperature - 77 if the July temperature is greater than 77°F, 0 otherwise.

JANUARYC: This is the category for areas with cold winters. It is equal to the average January temperature if it is less than 42°F and 42 otherwise.

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1. See Chapter V, pages 33-34 and Table I.

JANUARYP: This has the preferred mix of summer and winter temperatures. It is equal to average January temperature - 42 if the January temperature is greater than 42°F and the corresponding July temperature is less than 77°F, 0 otherwise.

JANUARYH: It represents areas with warm winters and hot summers. It is equal to average January temperature - 42 if the January temperature is greater than 42°F and the corresponding July temperature is greater than 77°F, 0 otherwise.

At first glance, it appears as though the categories are the same. They do overlap and JULYP and JANUARYP are looking at the same climatic range. However, the variables are measuring responses to different aspects of temperature variations. For example, JULYP measures the response of wages and land prices to warmer summers given the severity of the winter, while JANUARYP measures the response to changes in winter temperatures given the summer temperatures. Based on existing information with regard to individual preferences, I expect individuals to be willing to accept lower wages for living in SMSAs with warm winters. They can also be expected to accept wage cuts for warmer summers (some summers are too cold), but only up to a point. If summers become very hot workers will demand compensation for putting up with the hot climate.

The amount of annual rainfall in inches was also included. Rainfall has a dual effect. By reducing the amount of time available for the pursuit of leisure activities it acts as a disamenity. On the other hand rain increases agricultural productivity and lowers the cost of water. It also increases the forest area and reduces the likelihood of forest fires. These factors exert a downward pressure on wages. The net effect will depend on the relative strengths of the conflicting influences at work. Land prices may also respond either way.

Cities with beaches along the Gulf of Mexico, the Atlantic or the Pacific coasts were singled out. A dummy variable taking the value one when the SMSA had a beach and zero when it did not was included in the regressions. The presence of a beach increases the recreational potential of a SMSA and, hence, the utility of the residents. Land along the coast is limited and competition for it results in higher prices for it relative to land in surrounding areas not on the beach. Therefore, I expect the variable to have a positive coefficient in the land price equation. The effect on wages is not definite. The amenity effect will reduce wages but the increased cost of land will lead to cost of living increases in wages.

CHAPTER V
EMPIRICAL RESULTS

This chapter presents the results of the SSUR (seventeen equation SUR) estimation and the results of the two step procedure using city dummies. Let us first look at the SSUR results. Tables II-IV summarize these results. Table II summarizes information on the distribution of the regression coefficients of the sixteen wage equations in the SSUR. Table III gives the results of the Pearson's P_g test for significance of individual variables in the wage equations. Also included is information on the number of individual coefficients that had absolute t statistics greater than 1.296 and their signs.

The Pearson's P_g test is run by calculating the probability of obtaining a coefficient as high as the one obtained assuming the null hypothesis to be true, for each case. Let the probabilities be denoted by p_i. Then if there are n independent equations, $_g = \Sigma_{i=1-k}(-2\ln p_i)$ has a chi-square distribution with degrees of freedom 2n.

The wage equations are part of an SUR system and, hence, not independent. However, the coefficients obtained for the SUR have the same signs as the OLS (ordinary least squares) estimates and are close in magnitude also. I also

ran F tests for significance of the wage coefficients. The F test is valid for the SUR results in large samples only. Hence, both test results are reported in Table III. In the text I have discussed the F test results only when they are different from the results of the Pearson's P_g test.

Table IV presents the regression coefficients and the associated standard errors for the land price equation. All coefficients significant at the 10% level are marked by an asterisk. In each case the test conducted is a one-sided test.

The human capital variables MARRIAGE and FOREIGN have the expected effect on wages. Workers with poor English skills earn less than workers fluent in English. According to the Pearson's P_g test married men earn up to 0.65% more than single men. This supports existing evidence (Kenny 1983). The F test, however, finds the coefficient of MARRIAGE to be insignificant.

The results also suggest that workers prefer to live in cities with a higher percentage of whites. A 10% increase in the white population depresses wages by 1.2% on average. The coefficients obtained can also be interpreted as evidence that blacks receive higher wages, but existing information based on micro data tells us that blacks earn less than whites. On the other hand, racial preferences are important in determining choice of residence, which is

demonstrated by the presence of "white" neighborhoods in SMSAs. These results are confirmed by the F tests.

All the variables influencing the local land market have significant effects on the price of residential land except for the AREA variable. A 10% increase in SMSA population increases land prices by 1.6%, while a 10% increase in the price of agricultural land increases residential land prices by 2.3% on average. This is consistent with theory that the price of urban land is affected by the price of the surrounding agricultural land and the number of people in the metropolitan area.

All of the local land market variables, including the AREA variable, are significant (according to the Pearson's P_g test) in the wage equation. A 10% increase in SMSA population increases wages by 0.18%, while a 10% increase in the price of agricultural land increases wages by 0.14% on average. The F tests support these results except for LOGPOP, which is found to have no significant effect on wages. These results are consistent with the model's predictions and evidence obtained by other researchers.

Turning to the other land market variables, I find that increases in the unemployment rate are accompanied by a decline in the price of residential land and an increase in wages. The theory of compensating wages predicts that workers will receive higher wages to compensate them for the increased risk of unemployment. High unemployment

rates mean consumers have more leisure. In equilibrium utility is constant. The resulting consumption bundle include fewer goods, such as housing, and more leisure. Demand for land is reduced and land prices are lower.

The response of land prices to restrictions on SMSA area is positive though not significant. This is surprising in view of the significant and positive response of wages to this variable. If the supply of additional land is limited, the price of existing land increases. This results in a cost of living increase in wages. The results of the SUR show evidence of increasing wages but not of increasing land prices.

Let us now turn to the amenity effects. Both wages and land prices are significantly higher for coastal SMSAs. The land price response is as predicted. The response of wages suggests a strong cost of living effect. The presence of a beach increases ln land price per square foot by \$ 0.28 and land price per square foot by \$ 0.7 on average.[1] Following Kenny and Denslow (1980), this suggests that the coefficient of BEACH in the (ln) wage regression should lie between 0.025 and 0.054. The mean value of the BEACH coefficients is 0.047. This is consistent with the prediction and allows for the presence of a small amenity effect.

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1. The average price per square foot is \$ 2.50.

None of the temperature variables have any significant effect on land prices. The signs of the variables are consistent with the predictions made earlier except in the case of JANUARYP.

In general, higher January temperatures are associated with lower wages. The coefficients of all the JANUARY variables are negative in the wage equations. Increases in July temperatures are also viewed as an amenity up to a point, coefficients for JULYC and JULYP are negative. July temperatures higher than 77°F, measured by JULYH, are viewed as a disamenity as is demonstrated by the positive coefficient for this variable.

In Chapter III, I outlined the predictions of the model with respect to amenities. If the amenity is not scarce, it does not affect land prices and its coefficient in the wage regression is negative. Scarce amenities increase land prices. This results in cost of living increases in wages. The net effect on wages is indeterminate. However, scarcity makes the amenity's coefficient in the wage regression more positive.

Table II indicates that the coefficients of the JULY variables in the wage equations from the SSUR satisfy these conditions on the average. The climate conditions defined as JULYC are not scarce. Therefore, there is only a pure amenity effect on wages. The hypothesis that the climate characterized as JULYP is scarce is supported.

Due to the presence of a cost of living effect, the coefficient of JULYP is more positive than the coefficient of JULYC (confirmed by a F test). JULYH is a disamenity and, hence, its coefficient is positive.

According to the Pearson's P_g test, the JANUARY variables all have negative coefficients. This reflects the fact that if other factors are held constant consumers like warmer winters. The F tests are mostly consistent with the above results. The F test finds JANUARYP to be statistically equal to zero. To test the hypothesis that the climate defined by JANUARYP is scarce, I also ran a F test for JANUARYH = JANUARYP. The test was negative. The cost of living effect offsets the pure amenity effect of the variable, making the coefficient of JANUARYP more positive than the coefficient of JANUARYH. This is consistent with the predictions of the model for scarce amenities.

As mentioned earlier, none of the temperature variables have statistically significant coefficients in the land price equation. Thus, the land market results do not support the hypothesis that a temperate climate is scarce.

However, a look at the land price data tells us that the evidence of the wage equations is not rejected. Table I lists the SMSAs in the "scarce" region. Ten out of the eleven are located in California. In addition, these

SMSAs are among the most expensive with respect to land prices. All but two of the California SMSAs are located on the coast. California is a large state with varied climate. The coastal region has a temperate climate. However, a large section is part of the National Forest System. As you move east, mountains and a National Forest limit the land available to the coastal cities. In addition, temperatures rise sharply as you move inland across the mountains. Thus, land with the preferred climate conditions is scarce. This is supported by the evidence from the wage equations. It also suggests a combination of the temperature variable with the coastal dummy. Unfortunately, the sample size for coastal SMSAs with ideal climate conditions is too small to obtain meaningful results. It is possible that the climate coefficients in the land price equation may be insignificant due to the relatively small number of cities in the preferred region. There may also be measurement bias in the value of residential land. The land price data come from FHA mortgages, which cannot exceed 100,000 dollars. This biases the data base. Low income families and families with smaller houses are over represented.

Wages increase as annual rainfall increases from 0" to 31". Further increases have no significant influence on wages.

Land prices fall 8.6% for a 10% increase in RAIN1 while a similar increase in RAIN2 results in a fall of 0.56% only. This is a strange result. A certain amount of rain is required for agriculture. Land prices should not decline as annual rainfall increases.

Increased pollution levels tend to lower land values, but as pollution levels rise beyond 53 mgs/m^3, the effect on land prices ceases to be significant. When pollution levels are relatively low, the pollution is often localized. Workers can usually avoid it by moving to nearby rural areas. This reduces the demand for land and land prices fall. High pollution levels indicate that the problem is unlikely to be localized. Therefore, the only effect is on wages. The evidence from the wage equation is also consistent with the model. The Pearson's P_g test finds the coefficients of both PARTICULATE1 and PARTICULATE2 to be positive and significant. The F test does not find PARTICULATE1 to be significant.

Increases in property crime levels do not have a significant effect on land prices. Land prices fall as the rate of violent crime increases from 0 to 560 per 100,000 of population. Additional increases in the rate of violent crime rate do not affect land prices significantly.

The coefficient of PCRIME1 is negative and significant in the wage regressions while the coefficient

of PCRIME2 is positive and significant. The coefficient of VCRIME1 is also negative and significant in the wage regressions. Further increases in violent crime have no significant influence on wages. The negative coefficients are inconsistent with the model's predictions.

By and large, the results obtained are consistent with the theoretical predictions of the model. The behavior of the rain variable is not exactly as predicted. However, the possibility of measurement errors and the limitations of sample size suggest that the fault is not in the model. The response of wages to low levels of crime is also questionable. As mentioned earlier, a possible reason for this may be that crime is often concentrated in small sections of the SMSA and many residents can avoid it by locating in other parts of the city.

We turn now to the results obtained from the SMSA dummies regression. Table V presents the coefficients from the regression of estimated city dummy coefficients and land prices on various city characteristics. The system was estimated jointly using SUR. All coefficients significant at the 10% level are marked by an asterisk. In each case the test conducted is a one-sided t test.

The first step consisted of regressing the wage observations (over 1600 in number) on dummy variables for age, education and SMSAs. For this regression seven of the eight educational categories were each represented by a

dummy variable. The group consisting of men with four years of high school was omitted. The results of the first step are tabulated in Appendix D. The coefficients of the education and age dummies were significant and had the expected signs. Earnings increased with age and education. This is consistent with theoretical predictions.

The coefficients of the SMSA dummies obtained from this regression were then regressed on human capital variables (MARRIAGE, WHITE and FOREIGN), variables influencing the local land market and amenities. A regression of land prices on variables influencing the local land market and amenities was also run. The results of these regressions are presented in Table V.

The results for the land price equation are almost identical to those obtained for the earlier SSUR. Not only do the coefficients have the same signs, but the magnitudes of the coefficients are also very close. The one exception is the negative coefficient of JANUARYP. This is inconsistent with theory and the earlier results.

The "wage" regression results are largely consistent with the earlier SSUR results. The coefficients of FOREIGN and MARRIAGE are no longer significant. The coefficient of WHITE is significant and negative as in the SSUR. The land market variables all have significant coefficients and the signs are as in the SSUR.

The response to the climate amenities is a little different from the earlier SSUR. The variables JANUARYP and JULYP are no longer significant. This indicates the presence of a cost of living effect and is consistent with the predictions outlined in Chapters III and Chapter IV. In contrast to the earlier results the coefficient of RAIN1 is no longer significant.

Among the other amenities, PART1 is no longer significant. Of the crime variables, both VCRIME1 and PCRIME1 are not significant.

The results obtained from the SMSA dummies regression are fairly good and support the evidence of the SSUR. As mentioned in Chapter III, the regression also demonstrates that the spline points estimated are invariant to changes in specification.

TABLE I: LOCATION AND LAND PRICE RANK OF SMSAS IN PREFERRED TEMPERATURE RANGE

SMSA RANK	STATE	TYPE	LAND PRICE
Anaheim-Santa Ana-Garden Grove	California	Coastal	4
Los Angeles Long Beach	California	Coastal	6
Modesto	California	Inland	10
Oxnard-Simi Valley-Ventura	California	Coastal	8
Sacramento	California	Inland	22
San Diego	California	Coastal	2
San Jose	California	Coastal	1
San Francisco Oakland	California	Coastal	3
Santa Rosa	California	Inland	5
Vallejo-Napa Fairfield	California	Coastal	11
Tacoma	Washington	Coastal	46

TABLE II: SOME SUMMARY STATISTICS ON THE DISTRIBUTIONS OF COEFFICIENTS FOR THE WAGE EQUATIONS IN THE SSUR ESTIMATION

VARIABLE	MEAN	VARIANCE	MINIMUM	MAXIMUM
AREA	0.0423	0.0034	-0.0278	0.1443
BEACH	0.0466	0.0009	-0.0103	0.1085
FOREIGN	-0.0026	$3X10^{-5}$	-0.0122	0.0045
JANUARYC	-0.0026	$6X10^{-6}$	-0.0064	0.0019
JANUARYP	-0.0027	$8X10^{-5}$	-0.0244	0.0091
JANUARYH	-0.0045	$1X10^{-5}$	-0.0114	0.0014
JULYC	-0.0042	$5X10^{-5}$	-0.0163	0.0056
JULYP	-0.0031	$4X10^{-5}$	-0.0140	0.0059
JULYH	0.0074	$2X10^{-5}$	0.0020	0.0159
LPAGR	0.0141	0.0002	-0.0108	0.0358
LOGPOP	0.0188	0.0003	-0.0224	0.0480
MARRIAGE	0.0023	$1X10^{-5}$	-0.0045	0.0077
PART1	0.0017	$2X10^{-6}$	-0.0002	0.0049
PART2	0.0007	$2X10^{-7}$	-0.0003	0.0017
PCRIME1	-0.0005	$2X10^{-6}$	-0.0028	0.0016
PCRIME2	$2X10^{-5}$	$3X10^{-1}$	$-2X10^{-5}$	$5X10^{-5}$
RAIN1	0.0016	$7X10^{-6}$	-0.0026	0.0052
RAIN2	-0.0003	$6X10^{-7}$	-0.0020	0.0008
UR	0.0135	$9X10^{-5}$	-0.0073	0.0347
VCRIME1	-0.0001	$3X10^{-8}$	-0.0005	0.0002
VCRIME2	$-3X10^{-6}$	$3X10^{-9}$	-0.0001	0.0001
WHITE	-0.0008	$5X10^{-6}$	-0.0019	0.0002

Table II continued .....

VARIABLE	MEAN	VARIANCE	MINIMUM	MAXIMUM
INTERCEPT	7.1953	15.3985	0.8111	13.9800

TABLE III: CHI-SQUARE VALUES AS OBTAINED FROM THE PEARSON'S P_g TEST FOR THE COEFFICIENTS OF THE WAGE EQUATIONS IN THE SSUR

VARIABLE	COEFFICIENTS FOR WHICH t>1.296	t<-1.296	H_o	g
AREA*a	6	0	$\beta>0$	70.77
BEACH*a	9	0	$\beta>0$	92.87
FOREIGN*a	0	6	$\beta<0$	71.44
JANUARYC*a	0	10	$\beta<0$	103.44
JANUARYP*	0	3	$\beta<0$	44.08
JANUARYH*a	0	6	$\beta<0$	90.86
JULYC*a	1	8	$\beta<0$	90.38
JULYP*	1	6	$\beta<0$	68.61
JULYH*a	10	0	$\beta>0$	85.38
LPAGR*a	7	0	$\beta>0$	79.28
LOGPOP*	3	0	$\beta>0$	58.67
MARRIAGE*	4	0	$\beta>0$	46.36
PART1*	4	0	$\beta>0$	50.94
PART2*a	10	0	$\beta>0$	82.34
PCRIME1*a	2	5	$\beta<0$	46.93
PCRIME2*a	10	1	$\beta>0$	77.35
RAIN1*a	5	0	$\beta>0$	52.69
RAIN2	0	1	$\beta<0$	32.96
UR*a	9	0	$\beta>0$	98.66
VCRIME1*a	1	6	$\beta<0$	59.24
VCRIME2	0	0	$\beta>0$	23.71
WHITE*a	0	7	$\beta<0$	72.25

Table III continued ......

Note: An asterisk denotes a coefficient significant at the 10% level for the Pearson's P_g test. The chi-square ninety value for 30 degrees of freedom is 41.00 and the chi-square ninety-five value for 30 degrees of freedom is 43.8. The test statistic is distributed with 32 degrees of freedom. An "a" denotes that the variable passed the F test for significance. I also ran a F test for overall significance of the wage regressions. The F value is 3.2505, i.e., the regressions are significant at the 5% level.

TABLE IV: COEFFICIENT ESTIMATES AND THEIR STANDARD ERRORS FOR THE LAND PRICE EQUATION IN THE SSUR

VARIABLE	COEFFICIENT	STANDARD ERROR
AREA	0.1896	0.1640
BEACH*	0.2799	0.1198
JANUARYC	0.0022	0.0075
JANUARYP	-0.0354	0.0285
JANUARYH	0.0033	0.0121
JULYC	-0.0019	0.0155
JULYP	0.0104	0.0162
JULYH	-0.0100	0.0200
LPAGR *	0.2310	0.0568
LOGPOP *	0.1606	0.0833
PART1 *	-0.0125	0.0082
PART2	0.0010	0.0021
PCRIME1	-0.0018	0.0042
PCRIME2	$4X10^{-5}$	$5X10^{-5}$
RAIN1 *	-0.0320	0.0088
RAIN2 *	-0.0061	0.0045
UR *	-0.0593	0.0347
VCRIME1 *	-0.0012	0.0006
VCRIME2	0.0002	0.0003
INTERCEPT	3.1417	11.7990

Note: Coefficients significant at the 10% level are marked by an asterisk. The test conducted is a one-sided t test in each case. The R-Square for the system is 0.511. The

Table IV continued.....

mean squared error for the system is 0.993 with 1329 degrees of freedom.

TABLE V: REGRESSION COEFFICIENTS AND STANDARD ERRORS OF THE TWO STAGE CITY DUMMIES SUR

	DEPENDENT VARIABLE	
INDEPENDENT VARIABLE	ESTIMATED COEFFICIENTS OF SMSA DUMMIES	LN AVERAGE LAND PRICE
FOREIGN	-0.0019	
	(0.0028)	
MARRIAGE	0.0045	
	(0.0036)	
WHITE	-0.0008*	
	(0.0005)	
AREA	0.0436*	0.1796
	(0.0298)	(0.1650)
BEACH	0.0445*	0.3114*
	(0.0223)	(0.1220)
JANUARYC	-0.0027*	0.0019
	(0.0014)	(0.0076)
JANUARYP	-0.0023	-0.0458*
	(0.0055)	(0.0304)
JANUARYH	-0.0047*	0.0028
	(0.0024)	(0.0125)
JULYC	-0.0047*	-0.0024
	(0.0030)	(0.0157)
JULYP	-0.0037	0.0112
	(0.0031)	(0.0164)

Table V continued .....

INDEPENDENT VARIABLE	DEPENDENT VARIABLE: ESTIMATED COEFFICIENTS OF CITY DUMMIES	DEPENDENT VARIABLE: LN AVERAGE LAND PRICE
JULYH	0.0077*	-0.0094
	(0.0038)	(0.0208)
LPAGR	0.0146*	0.2337*
	(0.0108)	(0.0582)
LOGPOP	0.0224*	0.1614*
	(0.0165)	(0.0846)
PART1	0.0016	-0.0136*
	(0.0015)	(0.0083)
PART2	0.0006*	0.0009
	(0.0004)	(0.0021)
PCRIME1	-0.0005	-0.0013
	(0.0008)	(0.0043)
PCRIME2	$2X10^{-5}$*	$4X10^{-5}$
	($1X10^{-5}$)	(0.0001)
RAIN1	0.0018	-0.0344*
	(0.0019)	(0.0090)
RAIN2	-0.0003	0.0064*
	(0.0008)	(0.0045)
UR	0.0135*	-0.0643*
	(0.0064)	(0.0357)

Table V continued .....

INDEPENDENT VARIABLE	DEPENDENT VARIABLE: ESTIMATED COEFFICIENTS OF CITY DUMMIES	DEPENDENT VARIABLE: LN AVERAGE LAND PRICE
VCRIME1	0.0001	-0.0012*
	(0.0001)	(0.0006)
VCRIME2	$3X10^{-6}$	0.0002
	(0.0001)	(0.0003)
INTERCEPT	6.9833*	2.3069
	(2.2152)	(11.9819)

Note: An asterisk denotes a coefficient is significant at the 10% level. The test conducted is a one-sided t test. The R^2 for the system is 0.660. The mean squared error for the system is 0.997 with 153 degrees of freedom.

CHAPTER VI
EDUCATION AND THE DEMAND FOR AMENITIES

This chapter looks at the changes in amenity demand with changes in education and experience. Given the assumptions of the model and consumer theory, consumption of normal goods increases as income increases while that of inferior goods declines. Therefore, we expect demand for amenities to be higher in the high-skill group relative to the low-skill group. In other words, the high-skill group will have a greater wage response to amenity variables.

Some studies have found evidence supporting this hypothesis. Henderson (1985) found that less educated individuals had lower willingness to pay elasticities for amenities such as less rain, clean air and warm weather. Roback (1988) ran regressions testing for the presence of regional wage differentials. She found that all regional wage differentials are eliminated when high-skill and low-skill individuals are separated. This suggests that the labor markets for the two groups are segregated. However, she did not investigate this any further.

As a crude test of the hypothesis, I separated the wage equations in the SUR into two groups and tested for

significant differences in the coefficients. The first group consisted of individuals whose educational qualifications ranged from no formal schooling to four years of high school. The second group consisted of individuals with at least one year of college. The Pearson's P_8 test was conducted on each group of eight equations. I also ran F tests to test for significance of variables and differences in response between the two education groups. The results are presented in Table VI.

It should be noted that the dependent variable used throughout is ln wage. The theoretical predictions outlined above are with respect to wages. The estimated coefficients presented in the previous chapter are,

$$\beta_i = (d \ln w)/dA_i.$$

Consumer theory predictions are with respect to,

$$\overline{\beta}_i = dw/dA_i = (dw/(d \ln w)).((d \ln w)/dA_i) = w_m\beta_i.$$

Here w_m is the mean wage for the group concerned. Tests for differences in wage response using the regression coefficients obtained are implicitly testing for a large income elasticity. Hence, I also ran tests for differences in wage response using $|w_m\beta_i|$. The results are all presented in Table VI.

There is strong evidence that education has an important role in determining worker response to changes in local land market conditions and demand for amenities. There is also evidence supporting the theory that low-skill and high-skill workers do not compete for the same jobs.

The results of the Pearson's P_g test and the F tests indicate that proficiency in English has a significant influence on the wages of low-skill workers only. This may be because foreign born individuals with high-skill levels are fluent in English while their low-skill counterparts are not. Another possibility is that the bulk of new immigrants consists of low-skill workers.

High-skill workers are also more sensitive to the racial composition of population. This is shown by the significantly larger value of $|\beta^h w^h|$ relative to $|\beta^l w^l|$, and the statistically significant, negative coefficient of WHITE for the high-skill group. The corresponding coefficient for the low-skill group is statistically insignificant. This is consistent with predictions that high-skill individuals have a greater demand for amenities.

The coefficient of MARRIAGE is statistically insignificant for the high-skill group but is significant and positive for the low-skill group. Kenny (1983) finds that marriage facilitates the financing of human capital by underprivileged males. This is consistent with the results obtained here.

The F tests find LOGPOP significant for high-skill men only, while the Pearson's P_g test finds LOGPOP to be significant for both groups. The F test results are consistent with theoretical predictions. As population increases, demand for land increases. This results in higher land prices, and increases the cost of living. The greater the amount spent on housing, the larger will be the effect of such increases. High-skill individuals spend more on housing. Hence, they are more affected by increases in population.

The Pearson's P_g test and the F tests find LPAGR to be significant and positive for both groups. The wage response for the high-skill group is greater than the wage response for the low-skill group. This is consistent with theory. High-skill workers have a larger absolute demand for land relative to low-skill workers. Therefore, when land prices increase they demand a larger amount of compensation.

The Pearson's P_g test finds the unemployment rate to be significant for both groups. The F tests find the unemployment rate to be significant for the low-skill group but not for the high-skill group. This indicates that local labor market conditions have less influence on the demand for high-skill workers. It is also consistent with existing evidence that finds less skilled workers are more likely to be laid off.

Both tests find AREA to be a significant variable for the two groups. The F test tells us that the response of wages to AREA is different for the two skill groups. As the high-skill group spends more on housing, it is more affected by land market conditions. Hence, it has a larger coefficient than the low-skill group. The mean coefficient value for the high-skill group is 0.0523 and for the low-skill group it is only 0.0193.

I will now discuss the wage response to amenities. The first amenity considered is temperature. In general, high-skill workers have a greater demand for amenities. However, cost of living adjustments in wages cloud the response of wages to amenities. It should also be noted that high-skill workers usually have jobs that require them to spend time indoors, in a controlled environment. Hence, the outdoor environment is of concern to high-skill workers for leisure activities only. It does not interfere with their ability to earn a living. Low-skill workers often work outdoors. Bad weather can increase the risk of job related injuries.

Looking at the last column in Table VI, we see that the high-skill group has a greater response to JANUARYC and JANUARYH. The wage response to JANUARYP is the same for both groups. In other words, the pure amenity response of wages is greater for the high-skill group. The higher amenity effect of JANUARYP, for the high-skill group, is

offset by the higher cost of living adjustment for this group. This is consistent with theoretical predictions.

The results for the JULY variables are divided. The high-skill group has a more positive wage response to the JULYH than the low-skill group. This supports the prediction that the pure amenity response of wages is greater for the high-skill group. However, the low-skill group is more responsive to JULYC. This is inconsistent with theoretical predictions. The high-skill group has a zero coefficient for JULYP, while the low-skill group has a negative coefficient. This suggests that the high-skill group demands a larger amount of compensation for increases in the cost of living, which is consistent with the theory.

The cost of living effect dominates the pure amenity effect with respect to coastal SMSAs for both groups. The high-skill group requires a larger increase in wages than the low-skill group. This is consistent with the other results and the model. In Chapter V I find a large price effect for land in coastal SMSAs. The high-skill group spends more on land. Hence, it requires more compensation when land prices increase.

The results also indicate that high-skill workers have a greater awareness of the disutility from increased rainfall. High-skill workers demand more compensation for

increases in RAIN1. Both groups are indifferent to increases in RAIN2.

According to the Pearson's P_g test, PARTICULATE1 is significant for high-skill workers but not for low-skill workers. The coefficient of PARTICULATE2 is significant for both groups. This suggests that low-skill workers are less willing to pay for clean air. In contrast, the F test concludes that neither group is affected by low levels of pollution, and only the low-skill group requires compensation for high levels of pollution. As mentioned earlier, high-skill workers usually work indoors in a controlled environment, while low-skill workers often work outdoors. Hence, low-skill workers are more affected by pollution.

Both groups have similar responses to high rates of property and violent crime. The high-skill group has a greater wage response to PCRIME2 and VCRIME1. There is no difference in the wage response to PCRIME1 and VCRIME2. This is mostly consistent with theory. The problem is that the Pearson's P_g test indicates that PCRIME1 has a negative coefficient for the low-skill group and VCRIME1 has a negative coefficient for the high-skill group. The F test concludes that PCRIME1 has no significant effect on either group, but the coefficient of VCRIME1 is significant and negative for the high-skill group. This is inconsistent with theoretical predictions.

TABLE VI: CHI-SQUARE VALUES FOR THE PEARSON'S P_g TEST FOR HIGH-SKILL AND LOW-SKILL WORKERS

VARIABLE	H_o	LOW-SKILL	HIGH-SKILL	HIGH-SKILL RESPONSE DIFFERENT	$\lvert\beta^h w^h\rvert > \lvert\beta^l w^l\rvert$
AREA	$\beta>0$	27.30*a	43.47*a	Yes, higher	Yes
BEACH	$\beta>0$	41.94*	50.93*a	Yes, higher	Yes
FOREIGN	$\beta<0$	64.34*a	7.10	Yes, higher	No
JANUARYC	$\beta<0$	69.12*a	34.32*a	No	Yes
JANUARYP	$\beta<0$	34.81*	9.27	No	No
JANUARYH	$\beta<0$	31.47*a	59.39*a	Yes, lower	Yes
JULYC	$\beta<0$	82.82*a	7.56	Yes, higher	No
JULYP	$\beta<0$	61.34*a	7.27	Yes, higher	No
JULYH	$\beta>0$	29.07*	56.31*a	Yes, higher	Yes
LPAGR	$\beta>0$	49.98*a	29.30*a	No	Yes
LOGPOP	$\beta>0$	25.10*	33.57*a	Yes, higher	Yes
MARRIAGE	$\beta>0$	33.32*a	13.04	Yes, lower	No
PART1	$\beta>0$	17.43	33.51*	No	No
PART2	$\beta>0$	51.64*a	30.70*	Yes, lower	No
PCRIME1	$\beta<0$	26.92*	20.01	No	No
PCRIME2	$\beta>0$	46.60*	30.75*a	Yes, higher	Yes
RAIN1	$\beta>0$	12.57	40.12*a	Yes, higher	Yes
RAIN2	$\beta<0$	17.41	15.55	No	No
UR	$\beta>0$	74.92*a	23.74*	Yes, lower	No
VCRIME1	$\beta<0$	13.37	45.87*a	Yes, lower	Yes
VCRIME2	$\beta>0$	10.35	13.36	No	No
WHITE	$\beta<0$	21.02	51.23*a	Yes, lower	Yes

Table VI continued .....

VARIABLE	H_o	LOW-SKILL	HIGH-SKILL	HIGH-SKILL RESPONSE DIFFERENT	$\lvert\beta^h w^h\rvert > \lvert\beta^l w^l\rvert$
INTERCEPT	$\beta>0$	89.71*a	60.35*a	Not applicable	

Note: An asterisk denotes a variable significant at the 10% level for the Pearson's P_g test and an "a" denotes a variable found significant by the F test. The chi-square ninety value for 16 degrees of freedom is 23.5 and the chi-square ninety-five value for 16 degrees of freedom is 26.3. $_g$ is distributed as chi-square with 16 degrees of freedom.

β^h and β^l represent estimated coefficients for the high-skill and low-skill group respectively, while w^h and w^l are the mean wages for the two groups.

I ran a F test for overall differences between the two groups. The test indicated that the two groups had significantly different responses to the variables. The F value was 3.0329.

CHAPTER VII
CONCLUSION

As explained earlier, amenities affect wages in two ways. The direct effect of increased amenity levels tends to lower wages. When amenities are scarce there is an indirect effect on wages that tends to increase wages. If an amenity is scarce, land prices increase. Utility must remain constant in equilibrium. Hence, there is a compensating increase in wages. The net effect on wages is indeterminate.

A sample consisting of 119 SMSAs was used to estimate and test the model. The results, presented in Chapters V and VI indicate that amenities are important in the determination of wages. Wages increase as pollution and crime levels (disamenities) increase. Improved climate conditions decrease wages. This is consistent with theoretical predictions that the compensating variation in wages is negative for amenities and positive for disamenities.

The evidence also supports the hypothesis that only scarce amenities influence land prices. Beaches are a scarce amenity. Land prices in coastal SMSAs are substantially higher than land prices in inland SMSAs.

This results in a cost of living increase in wages. The net result is that wages in coastal SMSAs are higher than wages in inland SMSAs.

The wage regressions indicate that a temperate climate is a scarce amenity. The coefficient of JULYP is more positive than the coefficient of JULYC (both are negative). The coefficient of JANUARYP is also more positive than the coefficient of JANUARYH. This is consistent with the behavior of a scarce amenity as described in Chapter III. The land price regression does not support this. The JULY and JANUARY coefficients are all statistically insignificant. However, the regression results may not be telling the full story. The data indicate that coastal land with temperate climate (found in California) is scarce. Unfortunately, the number of such SMSAs is very small. Therefore, it is not feasible to examine this sample in greater detail. There is also a bias in the land price data towards low income families and families with smaller homes (see Chapters IV and V).

I also show that workers' demands for amenities vary with their educational qualifications. High-skill workers have a higher demand for amenities such as clean air, a beach and a nice climate. They also demand greater compensation for increases in the price level. This is consistent with consumer theory.

APPENDIX A
THE ROLE OF NON-NEUTRAL AMENITIES IN THE DETERMINATION OF WAGES AND RENTS

Non-neutral amenities are of two types, productive and unproductive. Productive amenities reduce the cost of production while unproductive amenities increase the cost of production. An example of the former is the presence of good surfing conditions near a surfboard factory. This lowers production costs by making it easy to test new designs before mass production starts. Clean air is an example of an amenity that may be unproductive, if firms have to install expensive emission control devices to keep the air clean. Nice weather is another amenity that may be unproductive, if it encourages absenteeism among workers.

Consider first the case when the amenity is productive, i.e., $C_s < 0$. If the amenity is not scarce, i.e., $r_s = o$, then,

(A.1) $dw/ds = -V_s/V_w < 0$, which is the same as (2.8).

(A.2) $$\begin{aligned} dz/ds &= (-V_wC_s + C_wV_s)/V_wt \\ &= (-C_s/t) - (dw/ds).(C_w/t) \\ &> 0. \end{aligned}$$

Increases in amenity levels increase consumer utility and the consumer's equilibrium condition is no longer satisfied. Wages must fall until equation (2.2) is satisfied once more. This lowers firms' production costs. In addition, firms find that the amenity lowers production costs directly. These two facts attract firms to areas with the amenity even when they are further away from the market. The increase in transportation costs is offset by the amenity's productive influence.

Let us now assume the amenity is scarce, i.e., $r_s > 0$.

(A.3) $dw/ds = -(V_r r_s + V_s)/V_w \gtrless 0$, which is the same as (2.10).

(A.4) $dz/ds = -(C_r r_s + C_s)/t - (dw/ds).(C_w/t) \gtrless 0$.

The sign of both gradients is indeterminate. As amenity levels increase, wages fall but rents increase. This exerts upward pressure on wages and transportation costs. The net effect on wages and transportation costs will depend on the relative magnitudes of the individual effects.

Consider now the case of an unproductive amenity. If the amenity is not scarce $r_s = 0$. The wage gradient is

as described in (A.1). The location gradient is as follows:

(A.5) $dz/ds = -C_s/t - (dw/ds)C_w/t \gtrless 0$.

Unproductive amenities increase production costs. This offsets the advantage to firms from lower wages. Depending on how unproductive the amenity is and how much wages fall, firms will choose the optimum distance from the market. If $r_s > 0$, i.e., the amenity is scarce then dw/ds is as described in (A.3) and,

(A.6) $dz/ds = -(C_r r_s + C_s)/t - (dw/ds).(C_w/t) \gtrless 0$.

The term $(-C_r r_s - C_s)/t$ is negative in this case. The direct effect of an amenity increase on the firm will be to reduce z. The net effect will depend on the behavior of wages. If wages fall by an amount large enough for $(-dw/ds).(C_w/t)$ to dominate the first term then distance will increase. In all other cases distance from the market will decrease.

There is only one change that results from the introduction of amenities into the production process. When the amenity is not scarce and it is unproductive, the sign of dz/ds is indeterminate. This contrasts with the result obtained in Chapter II where dz/ds is positive. All

other results are unchanged. The signs of the wage and location gradients are as before. The magnitude of the location gradient will vary with the size and direction of the amenity's productive effect.

APPENDIX B
NON-TRADED GOODS AND THE MODEL

The model described in Chapter II can be extended by the addition of a fourth sector, the non-traded goods sector. The most obvious example of a non-traded good is housing. Other examples include restaurants and theaters. The conclusions of the model are fundamentally the same as those in Chapter II. However, it is useful to consider a generalization that allows for the possibility that individuals may modify their consumption of amenities via a home production process. For example, residents of high crime areas may invest in high tech security systems, guard dogs, extra locks or a can of mace.

Assume wages and rents are the same in all sectors of the economy. Let the shares of land and labor used in non-traded goods production be denoted by l^y and N^y. The corresponding variables for the traded goods sector will be denoted as l^p and N^p. The price vector of non-traded goods relative to that of traded goods will be written as p(s). The rental price of land, r, is now one of several prices of non-traded goods included in p(s).

Consumer utility is now a function of X and H, where H represents non-traded goods. Hence, the relevant price variable in the indirect utility function is p(s) not r. The consumer's equilibrium now requires,

(B.1) $V(w,p;s) = k.$

The equilibrium condition for sector two (the traded goods sector) remains the same, i.e.,

(B.2) $C(w,r;s) + tz = 1.$

Assuming a CRS production function for the non-traded goods sector also, we have the following equilibrium condition for sector four.

(B.3) $G(w,r;s) = p(s).$

Here, G is the unit cost function for the non-traded goods sector. Equation (B.3) tells us that in equilibrium the cost of producing one unit of the non-traded good is equal to its price. The land market is as described in equation (2.5).

Differentiating the equilibrium conditions and solving simultaneously, the various gradients were obtained.

(B.4) $dw/ds = -(V_p(G_r r_s + G_s) + V_s)/(V_w + V_p G_w)$.

The introduction of the non-traded goods sector makes the "rent effect" term more complex, reflecting a secondary wage effect via sector four.

(B.5) $dz/ds = -(1/t)(C_r r_s + C_s + C_w(dw/ds))$.

(B.6) $dp/ds = G_r r_s + G_s + G_w(dw/ds)$.

As mentioned in Chapter II, C_s is generally equal to zero. Similarly, G_s can also be set equal to zero. Consider the case when $r_s = 0$, i.e., the amenity is not scarce.

(B.7) $dw/ds = -V_s/(V_w + V_p G_w)$.

The net change in utility due to an increase in wages is $(V_w + V_p G_w)$. It must be positive. Hence, dw/ds is negative. Note that $(V_w + V_p G_w) < V_w$. Therefore, in absolute magnitude dw/ds is larger than in the single commodity model. Increased amenity levels increase consumers' utility. This attracts workers until wages fall and equation (2.2) is satisfied. The decline in wages makes non-traded goods cheaper. This leads to yet another increase in consumer utility, which in turn leads to a further decline in wages. Thus, a multiplier effect takes

place. As a result, wages fall more in the four sector model. The multiplier is larger, the greater the share of labor in sector four and the greater the proportion of income spent on non-traded goods. The multiplier effect is also discussed in Tolley (1974).

(B.8) $dz/ds = (-C_w/t)dw/ds > 0$, as discussed in the three sector model in Chapter II.

Note that the multiplier effect discussed above will increase the magnitude of this gradient also.

(B.9) $dp/ds = G_w dw/ds < 0$.

Again, increased amenity levels lower wages, and prices in sector four fall. This decline will increase with increased labor participation in sector four and/or increased consumer expenditure on non-traded commodities.

When $r_s > 0$, the pure amenity effect is offset by the rent effect. The gradients are smaller in absolute magnitude, and if r_s is very large, the signs may be reversed relative to the case of $r_s = 0$. In general, the signs of the gradients are ambiguous.

In sum, we see that when the amenity is not scarce, an increase in amenity levels lowers wages and the price of non-traded goods. When the amenity is scarce, rents

increase as amenity levels increase. Depending on the magnitude of the rent increase and the share of rent in household expenses, this may reverse the amenity effects on wages and price of non-traded goods. In any case, it will offset them and decrease their magnitude.

APPENDIX C
DEFINITIONS OF VARIABLES AND THEIR UNITS OF MEASUREMENT

1. AREA: The percentage of a SMSA's perimeter that cannot be extended beyond current limits due to the presence of barriers such as oceans, mountains, marshlands, national parks, historical sites, etcetera, expressed as a decimal number.
   Source: Rand McNally Road Atlas (1986).

2. BEACH: Variable that takes the value one when the SMSA has a beach on the Atlantic or Pacific oceans, or the Gulf of Mexico and zero otherwise.
   Source: Rand McNally Road Atlas (1986).

3. EDUCATION: There are eight educational categories.
   (a) 0--7 years of elementary school, assigned value 3.5.
   (b) 8 years of elementary school, assigned value 8.
   (c) 0--3 years of high school, assigned value 10.

(d) 4 years of high school, assigned value 12.

(e) 0--3 years of college, assigned value 14.

(f) 4 years of college, assigned value 18.

(g) 5 & 6 years of college, assigned value 19.5.

(h) ≥ 7 years of college, assigned value 22.

Each category is assigned an educational value that measures mean educational experience of the group. Source: Census of Population Volume I (1980).

4. FOREIGN: Percentage of foreign born in the SMSA. Source: Census of Population Volume I (1980).

5. JANUARY: average daily January temperature. Source: Climatological Data (1986).[1]

6. JANUARYC: Defined to be JANUARY when JANUARY < 42 and 42 otherwise. Source: Climatological Data (1986).

7. JANUARYP: Defined to be JANUARY - 42 when JANUARY > 42 and JULY < 77, 0 otherwise. Source: Climatological Data (1986).

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1. All climate variables are thirty year averages.

8. JANUARYH: Defined to be JANUARY - 42 when JANUARY > 42 and JULY > 77, 0 otherwise.
Source: Climatological Data (1986).

9. JULY: Average daily July temperature.
Source: Climatological Data (1986).

10. JULYC: Defined to be JULY when JULY < 77 and JANUARY < 42, 0 if JULYP is not 0 and 77 otherwise.
Source: Climatological Data (1986).

11. JULYP: Defined to be JULY when JULY < 77 and JANUARY > 42, 0 otherwise.
Source: Climatological Data (1986).

12. JULYH: Defined to be JULY - 77 when JULY > 77, 0 otherwise.
Source: Climatological Data (1986).

13. LOGPOP: Ln of SMSA population in 1980.
Source: Census of Population, Volume I (1980).

14. LPAGR: Ln of the average value of land and buildings in agriculture per acre in counties containing the SMSA or adjacent to it. The

value used is a weighted sum with the weights proportional to the ease of accessibility of the SMSA from the county.
Source: City and County Data Book.

15. LPAVG: Ln of average value of residential land per square foot.
Source: FHA Homes (1981).

16. MARRIED: Percentage of men now married (excludes widowers and divorcees) in each of the two age groups in the SMSA.
Source: Census of Population, Volume I (1980).

17. PARTICULATE: Micrograms per cubic meter of particulates in 1980. The variable used is a weighted average of all reporting stations within SMSA. The number of observations taken by each station are used as weights.
Sources: EPA Air Quality Data (1983) and EPA Air Quality and Emission Trends Report (1983).

18. PARTICULATE1: Defined to be PARTICULATE when PARTICULATE < 53 and 53 otherwise.

Source: EPA Air Quality Data (1983) and EPA Air Quality and Emission Trends Report (1983).

19. PARTICULATE2: Defined to be 0 when PARTICULATE < 53 and PARTICULATE - 53 otherwise.
Source: EPA Air Quality Data (1983) and EPA Air Quality and Emission Trends Report (1983).

20. PCRIME: Total number of property crimes per 100,000 population in 1980. Property crimes are theft and breaking and entering.
Source: FBI Uniform Crime Reports (1980).

21. PCRIME1: Defined to be PCRIME when PCRIME < 2800 and 2800 otherwise.
Source: FBI Uniform Crime Reports (1980).

22. PCRIME2: Defined to be 0 when PCRIME < 2800 and PCRIME - 2800 otherwise.
Source: FBI Uniform Crime Reports (1980).

23. RAIN: Annual rainfall in inches.
Source: Climatological Data 1986.

24. RAIN1: Defined to be RAIN when RAIN < 31 and 31 otherwise.

Source: Climatological Data 1986.

25. RAIN2: Defined to be 0 when RAIN < 31 and RAIN - 31 otherwise.

Source: Climatological Data 1986.

26. UR: Defined as the mean of the unemployment rate in 1960, 1970 and 1980.

Sources: Census of Population, Volume I (1980), The City and County Data Book (1973 and (1977).

27. VCRIME: Total number of violent crimes per 100,000 population in 1980. Violent crimes are murder, aggravated assault, rape and burglary.

Source: FBI Uniform Crime Reports (1980).

28. VCRIME1: Defined to be VCRIME when VCRIME < 560 and 560 otherwise.

Source: FBI Uniform Crime Reports (1980).

29. VCRIME2: Defined to be 0 when VCRIME < 560 and VCRIME - 560 otherwise.
Source: FBI Uniform Crime Reports (1980).

30. WAGE: Ln of average weekly wage earned by men aged 35-44 and 45-54 when they worked for at least 35 hours per week and 40 weeks in the year.
Source: Census of Population, Volume I (1980).

31. WHITE: Percentage of white males in each of the two age groups in the SMSA.
Source: Census of Population, Volume I (1980).

32. YOUNG: A dummy variable taking the value one when the observation is drawn from the age group 35-44 years and zero when the observation is from the age group 45-54 years.
Source: Census of Population, Volume I (1980).

APPENDIX D
FIRST STAGE RESULTS FROM THE TWO STAGE SMSA DUMMIES SUR

The first step, in the two stage SMSA dummies SUR, consisted of regressing all the wage observations (more than 1600) on dummy variables for education, age-group and 118 SMSAs. OLS was used for this initial regression. The dependent variable was ln wage. The R^2 for the regression was 0.9298. The estimated coefficients for the education and age-group dummies are presented in Table VII. The coefficients of the SMSA dummies are not given. The education categories are as follows:

(a) 0--7 years of elementary school, i.e., ES1.

(b) 8 years of elementary school, i.e., ES2.

(c) 0--3 years of high school, i.e., HS1.

(d) 4 years of high school, i.e., HS2.

(e) 0--3 years of college, i.e., CS1.

(f) 4 years of college, i.e., CS2.

(g) 5 & 6 years of college, i.e., CS3.

(h) ≥ 7 years of college, i.e., CS4.

Each category is assigned a dummy variable that takes the value one when the observation is from the category and zero otherwise. Category (d) is omitted.

TABLE VII: SOME FIRST STAGE RESULTS FROM THE TWO STAGE SMSA DUMMIES SUR

VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR
YOUTH	-0.1038	0.0044
ES1	-0.2992	0.0088
ES2	-0.2058	0.0088
HS1	-0.1323	0.0088
CS1	0.1183	0.0088
CS2	0.3911	0.0088
CS3	0.4066	0.0088
CS4	0.6715	0.0088
INTERCEPT	6.1155	0.0247

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Archana Aggarwal obtained a B.A.(Honours) in economics from the University of Delhi, India in 1980. She received a M.A. in economics in 1982 from the same University.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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